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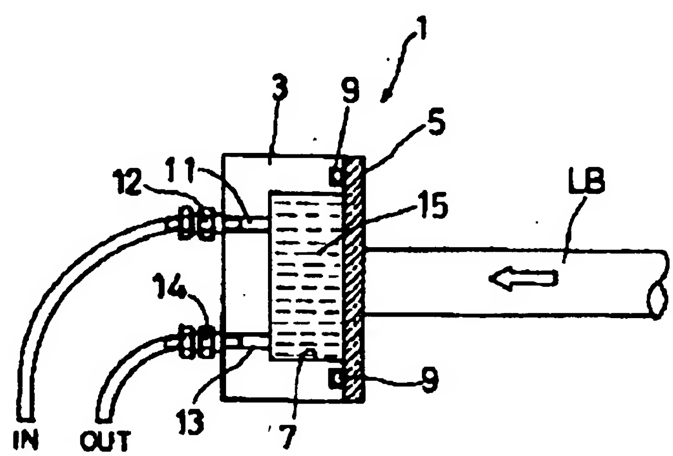
(54) **[Title of the Invention] Laser absorption apparatus having a laser light beam shutter**

(57) [Abstract]

[Object] Provide a laser light absorption apparatus having a laser light beam shutter which efficiently absorbs laser light, and further, wherein there is almost no drift in the absorption rate over time.

[Means of Solving the Problem] A laser light absorption apparatus having a laser light beam shutter wherein, on a laser light absorption apparatus having a laser light beam shutter 1, a cooling vessel 3 equipped with a laser beam light-intercepting window 5 is provided on said laser light absorption apparatus, and a laser light beam passing through the aforementioned laser beam light-intercepting window is absorbed by cooling liquid 15 flowing within said cooling vessel.



[Claims]

[Claim 1] A laser light absorption apparatus having a laser light beam shutter wherein a laser light absorption apparatus having a laser light beam shutter is provided with a cooling vessel equipped with a laser beam light-intercepting window on said laser light absorption apparatus, and laser light passing through the aforementioned laser beam light-intercepting window is absorbed by a cooling liquid flowing within said cooling vessel.

[Claim 2] The laser light absorption apparatus having a laser light beam shutter according to Claim 1 wherein the aforementioned cooling liquid is made to flow between a cooling liquid supply port and a discharge port of the aforementioned cooling vessel in a nearly rectilinear manner.

[Claim 3] The laser light absorption apparatus having a laser light beam shutter according to Claim 1 wherein the aforementioned cooling liquid is made to flow toward the surface of the aforementioned cooling vessel side on the aforementioned laser light-intercepting window.

[Claim 4] The laser light absorption apparatus having a laser light beam shutter according to Claim 1, Claim 2 or Claim 3 wherein water is used as the aforementioned cooling liquid.

[Detailed Description of the Invention]

[0001]

[Technical Field to Which the Invention Pertains] The present invention relates to laser absorption apparatuses having a laser light beam shutter.

[0002]

[Prior Art] In laser machining devices or laser measurement devices and the like, a shutter to gate laser light into the machining section or the measurement section is provided as necessary in the laser light propagation path which proceeds from a laser oscillator to the aforementioned machining section or measurement section.

[0003] Figure 4 shows a theoretical shutter for laser light. Laser light absorption apparatus 100 which absorbs laser light beam LB is provided so that, mechanically, it can be freely advanced into and withdrawn from laser light propagation path 101. Laser light absorption apparatus 100 comprises laser light absorption body 103 and air-cooled or water-cooled cooling apparatus 105 which cools this laser light absorption body 103.

[0004] Figure 5 shows another laser light absorption apparatus having a laser light beam shutter. It is provided with mirror 107 which can, mechanically, be freely advanced into and withdrawn from the aforementioned laser light propagation path 101. Laser light absorption apparatus 109 which intercepts laser light beam LB reflected by this mirror 107 is provided outside of laser light propagation path 101, and this laser light absorption apparatus 109 comprises V-shaped laser absorption body 111, and air-cooled or water-cooled cooling apparatus 113 which cools this laser light absorbing body 111.

[0005] The laser light absorbing bodies 103 and 111 in the aforementioned Figure 4 and Figure 5 use substrates of a metal having high thermal conductivity such as aluminum, copper and the like which have been subjected to a black Alumite treatment, or to which a ceramic film coating treatment has been applied, etc.

[0006] In the laser light absorption apparatus 100 of the aforementioned Figure 4, when the intensity of the laser light is higher than the irradiation resistance of laser light absorbing body 103, methods are also used to tilt laser light absorbing body 103, and thereby reduce the energy density of the laser light striking the light-intercepting surface.

[0007]

[Problems the Invention is to Solve] In the laser light absorbing bodies in the laser light absorption apparatuses having a laser light beam shutter of the prior art described above, the laser light absorbing surface gradually deteriorates from the laser light, and absorptivity declines. In other words, reflectivity gradually increases. For example, in [bodies] having an aluminum surface with a black Alumite treatment, decolorization gradually progresses and reflectivity gradually increases. In addition, in [bodies] having a ceramic film coating treatment, the surface thereof gradually whitens, and reflectivity gradually increases. When conditions such as these progress even further, the aluminum or copper, the subsurface metal subjected to the surface treatment, is exposed. The reflectivity of the aluminum or copper which comprises this subsurface metal is extremely high with respect to laser light, and there is a danger that reflected light from the laser light absorbing body will be reflected in an unforeseen direction.

[0008] Further, in addition to the fact that the laser light absorptivity of laser light absorbing bodies subjected to the surface treatments as described above is low at around 96%, there are problems in that the cost to treat the surface of the laser light absorbing bodies is also high.

[0009] Plus, with high-power lasers, the laser light absorbing body is tilted, thereby causing the energy density of the laser light at the intercepting surface to decline, but there are problems with this method in that the size of the laser light absorption apparatus becomes large.

[0010] The present invention gives careful consideration to problems like those described above, and the problem [*sic*] of the present invention is that it provides a laser light absorption apparatus having a laser light beam shutter in which laser light is absorbed efficiently, and further, in which there is almost no drift in absorptivity over time.

[0011]

[Means of Solving the Problem(s)] The means of solving the aforementioned problems is characterized in that the laser light absorption apparatus having a laser light beam shutter as set forth in Claim 1 is provided with a cooling vessel equipped with a laser beam light-intercepting window on said laser light absorption apparatus, and laser light passing through the aforementioned laser beam light-intercepting window is absorbed by a cooling liquid flowing within said cooling vessel.

[0012] Consequently, laser light can be efficiently absorbed by the flowing cooling liquid, and because the energy of the laser light is absorbed by the circulating cooling liquid, absorptivity drift over time is eliminated.

[0013] The laser light absorption apparatus having a laser light beam shutter described in Claim 2 is characterized in that, in the invention described in Claim 1, the aforementioned cooling liquid is made to flow between a cooling liquid supply port and a discharge port of the aforementioned cooling vessel in a nearly rectilinear manner.

[0014] Consequently, laser light can be efficiently absorbed by the flowing cooling liquid, and because the energy of the laser light is absorbed by the circulating liquid, absorptivity drift over time is eliminated. In addition, the cooling liquid can be circulated in an efficient manner.

[0015] The laser light absorption apparatus having a laser light beam shutter described in Claim 3 is characterized in that, in the invention described in Claim 1, the aforementioned cooling liquid is made to flow toward the surface on the aforementioned cooling vessel side of the aforementioned laser beam light-intercepting window.

[0016] Consequently, laser light can be efficiently absorbed by the flowing cooling liquid, and because the energy of the laser light is absorbed by the circulating liquid, absorptivity drift over time is eliminated. In addition, the cooling liquid can be circulated in an efficient manner.

[0017] The laser light absorption apparatus having a laser light beam shutter described in Claim 4 is characterized in that, in the inventions described in Claim 1, Claim 2 or Claim 3, water is used as the aforementioned cooling liquid.

[0018] Consequently, it has the advantages that, even in the unlikely event that cooling water leaks, it is harmless to humans, and its cost is low.

[0019]

[Mode for Carrying Out the Invention] Embodiments of the laser light absorption apparatus having a laser light beam shutter of the present invention will be explained below. Figure 1 is a first embodiment wherein, in laser light absorption apparatus 1, liquid chamber 7 is formed by fastening plate-like laser beam light-intercepting window 5, which is transparent to laser light beam LB, on the opening of box-shaped cooling vessel 3, which is open on one side, using an appropriate fastening means such as bolts. The longitudinal distance in the transmission direction in this liquid chamber 7 through which the laser light passes is appropriately set according to the output of the laser to be blocked. For example, when the output is around 1 kW to 2 kW, [a distance] of around 20 mm is appropriate. It should also be noted that, in order to be liquid-tight, it is fastened with a sealing element 9 such as an O-ring between cooling vessel 3 and the aforementioned laser beam light-intercepting window 5.

[0020] Cooling liquid supply port 11 and discharge port 13 are provided on the aforementioned cooling vessel 3, and are linked to a cooling liquid supply apparatus not shown in the drawing. It should also be noted that using water as cooling liquid 15 is most preferable in terms of maintenance and cost. Also note that an aqueous solution of copper sulfate ($CuSO_4$) or an aqueous solution of copper chloride ($CuCl_2$) employed as a transmissive-type attenuator may also be used.

[0021] In addition, a material whose transmissivity for laser light beam LB is nearly 100% must be used as the material for the aforementioned laser beam light-intercepting window 5. For a carbon dioxide gas laser, ZnSe or GaAe [*sic*] is preferred, and for a YAG laser, quartz, crystal, BK7 (a special glass), and the like, are preferred. In addition, fabricating the aforementioned cooling vessel 3 out of copper or aluminum and the like, which have high thermal conductivity, is preferred.

[0022] Based on the above-mentioned constitution, provided laser beam light-intercepting window 5 of this laser absorption apparatus 1 is placed in a position orthogonal to the beam path of the laser light, and cooling liquid 15 is being circulated in liquid chamber 7 of laser absorption apparatus 1, almost all of the laser light passing through laser beam light-intercepting window 5 will be absorbed by cooling liquid 15 flowing through the interior of this cooling chamber 7. Cooling vessel 3 whose temperature is elevated is then cooled by cooling liquid 15 circulating within liquid chamber 7.

[0023] Consequently, according to the laser light absorption apparatus having a laser light beam shutter 1 of this embodiment, laser light can be efficiently absorbed by the cooling liquid flowing therethrough, and because the energy of the laser light is absorbed by the circulating cooling liquid, absorptivity drift over time is eliminated.

[0024] Figure 2 is a second embodiment wherein, in laser light absorption apparatus 20, a rectilinear cooling liquid passage 23 is provided in cooling vessel 21, and liquid chamber 25, a single side-surface of which is open, is formed nearly in the center of this cooling liquid passage 23. Plate-like laser beam light-intercepting window 27 through which laser light beam LB passes is attached to the aforementioned open section of this single side-surface of liquid chamber 25 by light-intercepting window securing element 29 using fastening elements such as bolts. In order to be liquid-tight, a seal like an O-ring is provided between this light-intercepting window securing element 29 and laser beam light-intercepting window 27, and cooling vessel 21.

[0025] It should also be noted that piping couplings 35 are provided on the aforementioned cooling liquid passage 23 for the purpose of connecting piping to supply and discharge the cooling liquid, and a cooling liquid supply apparatus not shown in the drawing connects to the piping connected by these piping couplings 35.

[0026] Based on the constitution described above, provided laser beam light-intercepting window 27 of this laser light absorption apparatus 20 is placed in a position orthogonal to the beam path of laser light beam LB, and cooling liquid 15 is being circulated in liquid chamber 7 of laser absorption apparatus 20, almost all of the laser light beam LB passing through laser beam light-intercepting window 27 will be absorbed by cooling liquid 15 flowing through the interior of this cooling chamber 25. Cooling vessel 3 whose temperature is elevated is then cooled by cooling liquid 15 circulating within liquid chamber 7.

[0027] Consequently, according to the laser light absorption apparatus having a laser light beam shutter 1 of this embodiment, [laser light] can be efficiently absorbed by the cooling liquid flowing therethrough, and because the energy of the laser light is absorbed by the circulating cooling liquid, absorptivity drift over time is eliminated. In addition, because the cooling liquid flows rectilinearly in a direction from the supply port to the discharge port, the cooling liquid can be circulated efficiently with minimal flow resistance.

[0028] Figure 3 is a third embodiment wherein the components are identical to those of the aforementioned second embodiment, and the symbols annotated therein are also identical. Now, according to this third embodiment, a plural number of cooling liquid passages (23 and 26) are provided on cooling vessel 22 of laser light absorption apparatus 20 and at least one cooling liquid passage 26 of this plural number of cooling liquid passages (23 and 26) is provided in an orientation opposite to or facing the aforementioned light-intercepting window 27. It should also be noted that piping couplings 35 are provided on the aforementioned cooling liquid passages (23 and 26) for the purpose of supplying or discharging the cooling liquid.

[0029] Cooling liquid supply port 37 (or cooling liquid discharge port 37) of the aforementioned cooling liquid passage 26 established in an orientation opposite to or facing the aforementioned light-intercepting window 27 is provided, protruding in a cone-like shape within the aforementioned liquid chamber 25.

[0030] In the above constitution, when cooling liquid is supplied from cooling liquid passage 26 opposite to or facing light-intercepting window 27, the cooling liquid is sprayed against light-intercepting window 27, and cooling liquid reflected from light-intercepting window 27 is discharged by flowing out through a plural number of cooling liquid passages 23. Consequently, concurrent with further improvement in the cooling efficiency of the aforementioned light-intercepting window 27, cooling liquid is constantly and uniformly supplied opposite the optical axis of the laser, and thus local heating or local boiling of the cooling liquid as a result of cooling liquid flow distribution effects can be inhibited.

[0031] In addition, in the above constitution, when cooling liquid is supplied from a plural number of cooling liquid passages 23, cooling liquid is discharged from the aforementioned cooling liquid passage 26 by curving the direction of flow toward light-intercepting window 27 through cooling liquid discharge port 37 which protrudes in a cone-like shape inside liquid chamber 25. Consequently, the cooling efficiency of light-intercepting window 27 is improved in a manner similar to when cooling liquid is supplied from cooling liquid passage 26.

[0032] It should also be noted that the aforementioned third embodiment illustrates an example wherein cone-shaped cooling liquid supply port 37 is provided in one location in an orientation opposite to or facing light-intercepting window 27, but depending on the laser light beam diameter and beam mode, or the intensity of the laser light, by appropriately combining the number and arrangement of the cooling liquid passages (23 and 26), and the supply and discharge direction of the cooling liquid, it is possible to accommodate a wide variety of beam diameters, beam modes, or laser light intensities.

[0033] It should also be noted that couplings 35 for the purpose of connecting piping that supply or discharge the cooling liquid are provided, and a cooling liquid supply apparatus not shown in the drawing is connected to the piping connected to this coupling 35.

[0034]

[Advantageous Effects of the Invention] According to the invention set forth in Claim 1, by being able to efficiently cause laser light to be absorbed by a flowing cooling liquid, the energy of the laser light is absorbed by the circulating cooling water [*sic*], and thus absorptivity drift over time is eliminated. Consequently, there is no danger from laser light being reflected in an unforeseen direction as a result of deterioration of the laser light absorbing body, and thus safety is high.

[0035] According to the invention set forth in Claim 2, in addition to the advantageous effects of Claim 1, cooling liquid can be efficiently circulated, and thus operating costs can be reduced.

[0036] According to the invention set forth in Claim 3, in addition to the advantageous effects of Claim 1, cooling liquid can be efficiently supplied opposite the laser light beam, and thus high-intensity laser light can be absorbed by the cooling liquid.

[0037] According to the invention set forth in Claim 4, there are advantages in that even in the unlikely event of a cooling water leak, it is harmless to humans, and in addition, costs are low.

[Brief Explanation of the Figures]

[Figure 1] Figure 1 shows a first embodiment of a laser light absorption apparatus having a laser light beam shutter of the present invention.

[Figure 2] Figure 2 shows a second embodiment of a laser light absorption apparatus having a laser light beam shutter of the present invention.

[Figure 3] Figure 3 shows a third embodiment of a laser light absorption apparatus having a laser light beam shutter of the present invention.

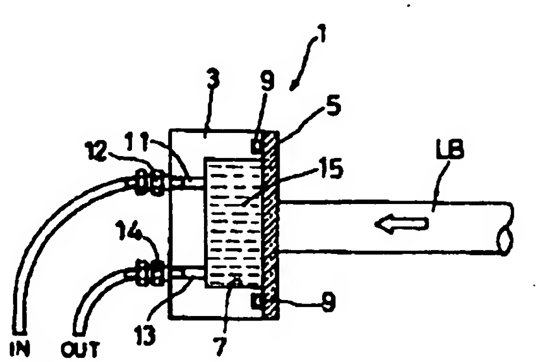
[Figure 4] Figure 4 shows a theoretical laser light absorption apparatus of the prior art having a laser light beam shutter.

[Figure 5] Figure 5 shows another theoretical arrangement of a laser light absorption apparatus of the prior art having a laser light beam shutter.

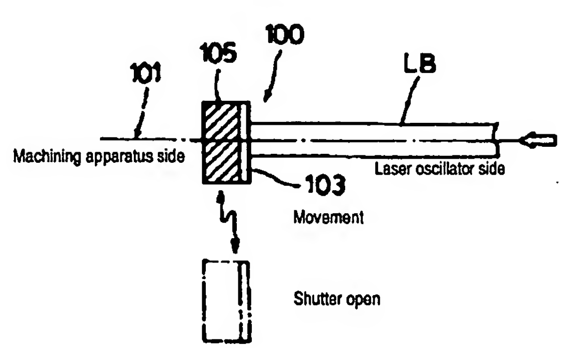
[Explanation of Symbols]

1 Laser light absorption apparatus
3 Cooling vessel
5 Laser beam light-intercepting window
7 Liquid chamber
11 Supply port
13 Discharge port
15 Cooling liquid
LB Laser light beam

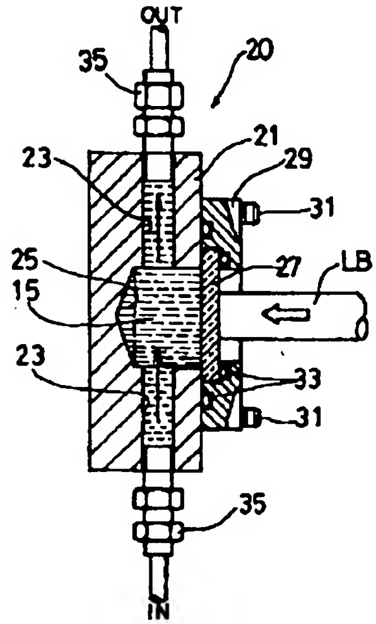
[Figure 1]



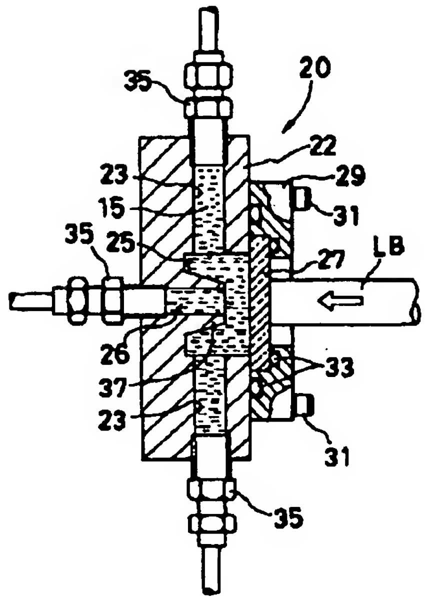
[Figure 4]



[Figure 2]



[Figure 3]



[Figure 5]